DOCUMENT RESUME

ED 166 050 SE 026 570

AUTHOR Lybeck, Leif
TITLE Research in Science Education: Sweden 1976. Paper Presented at the Council of Europe Contact Workshop (Malente-Gremsmuhlen, Kiel, West Germany, October 27-29, 1976). Reports from the Institute of Education, University of Goteborg, No. 74.
INSTITUTION Goteborg Univ., Molndal (Sweden). Inst. of Education.
PUB DATE Dec 78
NOTE 49p.; For related documents, see SE 026 568-569

EDRS PRICE MF-$0.83 HC-$2.06 Plus Postage.
DESCRIPTORS *Annual Reports; *Educational Research; Experimental Programs; *Program Descriptions; *Research; Research Projects; Research Reviews (Publications); *Science Education
IDENTIFIERS Research Reports; *Sweden

ABSTRACT

This is an annual report of science education research undertaken in Sweden in 1976. It includes reports on work done by government commissions and projects of national boards, a brief review of projects reported on in Swedish journals, and a report on recent trends in Swedish science education research and future plans. (BB)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

U S DEPARTMENT OF HEALTH,
EDUCATION & WELFARE
NATIONAL INSTITUTE OF
EDUCATION

THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL NATIONAL INSTITUTE OF EDUCATION POSITION OR POLICY

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY

Leif Lybeck

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC) AND USERS OF THE ERIC SYSTEM."

ED 026 570

CONCEPT FORMATION IN MATHEMATICS AND THE NATURAL SCIENCES, THE INTEGRATED UPPER SECONDARY SCHOOL (8)

RESEARCH IN SCIENCE EDUCATION: SWEDEN 1976

Paper presented at the Council of Europe Contact Workshop 'Research in Science Education in Europe. Improvement of research activities and results.' October 27--29, 1976, Malente-Gremsmühlen (Kiel), Federal Republic of Germany.

Leif Lybeck

No 74 December 1978

FORWORD

The Council of Europe Contact Workshop 'Research in Science Education in Europe. Improvement of research activities and results', October 27--29, 1976, Malente-Gremsmühlen (near Kiel), F R Germany, was organized by the Council of Europe and the Institute for Science Education (Institut für die Pädagogik der Naturwissenschaften (IPN), Kiel, FRG). The Contact Workshop was financially supported by The German Federal Ministry of Education and The Council of Europe.

The Preparatory Committee envisaged the following goals for the workshop:

1 A description of the areas and present level of research in science education.

2 A list of possible future objectives for research in science education and areas of application (possibly a list of priorities).

3 A discussion of the aims and procedures of cooperative projects among the member countries of the Council of Europe, possibly a list of possible areas for cooperative research projects, in order to improve research in science education (and its practical application) in member countries, external support for the recognition of research in science education.

4 A survey of the existing information system for research in science education in Europe; planning of some measures:
- a description of the tasks of national representatives of science education,
- possibly the establishment of a European journal of research in science education,
- a European newsletter on activities and news in research in science education;
- trend reports,
- development of links between institutions concerned with the training of teachers.

5 To find out how the linkage of the theory and practice of teaching science can be most effective.

6 A programme for an exchange of young researchers in science education and a discussion on how to finance the first phase.

7 Suggestions for a series of future European workshops on research in science education.

It is of great interest to quote the concept "research in science education" as formulated by the Preparatory Committee:

"The topic of the workshop "Research in Science Education" includes all systematic investigations within the area of science education. Curriculum development and textbook writing without the systematic investigation laid down in additional documents besides the curriculum material and the textbooks are not considered as research in science education. Research, however, in science education, is often connected with curriculum development and teaching.

Accordingly, the following topics - among others - are parts of research in science education:

- The constructive application of theories from related disciplines such as psychology, sociology, theory of science, logic, theory of planning, etc.

- Experimental research (a) with precise, quantitative designs or (b) with explicit, systematic, qualitative documentation of personal experiences.

- Theoretical studies, e.g. the construction of sophisticated frameworks for the development of concepts systems or sets of criteria.

The treatment of these problems of research should be permanently controlled by the following fundamental question:

By what means can theoretical knowledge which considers the general aims of (science) education and actual practice, be elaborated?"

I was asked by the Preparatory Committee to write the national Swedish report, which was completed during the summer 1976. This work was sponsored by the National Swedish Board of Education and IPN, Kiel. A shortened version of this paper has been published in the report of the workshop:

> RESEARCH IN SCIENCE EDUCATION IN EUROPE. Perspectives, Structural Problems and Documentation 1976. Report of a cooperative study and a European Contact Workshop organized by the Council of Europe and the Institute for Science Education - Federal Republic of Germany (Kiel). Edited by Karl Frey, Klaus Blänsdorf, Torsten Kapune, Gerhard Schaefer and Fred Archenhold. Amsterdam and Lisse: Swets & Zeitlinger, 1977.

For the first time on a European-wide basis research in science education has been analysed, documented and reported. The national reports, a synthesis of these national reports, and working papers containing other recommendations and plans were the background papers elaborated by the Work Groups during the meeting. Thus, a lot of creative works were carried out by the delegates. The reports of the Work Groups are to be find in the above mentioned book.

About 45 delegates (12 from FRG) participated in the Contact Workshop. Two Swedes were sent as delegates. During the conference we were asked to carry out the following survey:

> European Survey of Masters' and Doctors' Dissertations in Science Education, 16 IPN Report-in-Brief, 1978, by Bengt Kjöllerström and Leif Lybeck.

Mölndal October 1978
Leif Lybeck

CONCEPT FORMATION IN MATHEMATICS AND THE NATURAL SCIENCES, THE INTEGRATED UPPER SECONDARY SCHOOL is a translation from the Swedish name BEGREPPSBILDNING INOM MATEMATIK OCH NATURVETENSKAPLIGA ÄMNEN, GYMNASIESKOLAN (the BMN-project). The BMN-project is sponsored by the National Swedish Board of Education during the fiscal years 1975/79.

CONTENTS

GOVERNMENT COMMISSIONS AND PROJECTS OF NATIONAL BOARDS 2

The Preschool System 2

The School System 3

The University and the Teacher Training College 6

REPORTED RESEARCH PROJECTS ON SCIENCE EDUCATION 8

Sources 8

The Preschool System 9

The School System 10

The University and the Teacher Training College 19

TRENDS IN RESEARCH IN SCIENCE EDUCATION 21

The School System 21

The University 26

An Outline for a Research Project 27

NOTES 28

ACKNOWLEDGEMENT 30

REFERENCES 31

ADDRESSES 40

Ministries

National Boards

Research Councils

University Departments of Education

Teacher Training Colleges

GOVERNMENT COMMISSIONS AND PROJECTS OF NATIONAL BOARDS

The Preschool System

The 1968 Child Centre Commission (SOU 1972:26 & 27) submitted reports which have been circulated for consideration and comments by the bodies concerned. The Law of Preschool Activities gained legal force on July 1, 1975. Based on the reports and comments, the National Social Welfare Board in cooperation with the National Board of Education published ARBETSPLAN FÖR FÖRSKOLAN 1, 2 & 3 (1975) (Plan of Work for the Preschool).

An integration model for the preschool programme was introduced by The 1968 Child Centre Commission (SOU 1972:26). Principally, it is based on the cognitive theory of JEAN PIAGET, on the psychodynamic theory of E.H. ERIKSON and on the neuro-physiological theories (mainly molecular biological theories). With the theories of PIAGET and ERIKSON as a basis, three areas of competence are given: self-conception, concept formation and communication.

In SOU (1972:26), OLOF ERNESTAM (1972) submitted a programme for natural science concept formation in physics and chemistry and DICK ÅKERBLOM (1972) provided the biological counterpart. Some activities for older preschool children were suggested by ERNESTAM & SVERUD (1972:26). In the outline given by ERNESTAM (ARBETSPLAN FÖR FÖRSKOLAN 3, 1975), we can trace the influence of the American project: Science Curriculum Improvment Study (SCIS).

An evaluation study has been planned for ARBETSPLAN FÖR FÖRSKOLAN 1, 2 & 3 (ASPLUND, WESTER-HJELMSTEDT & ÅBERG, 1975). Firstly, the ARBETSPLAN must be evaluated in relation to organizational conditions (SVEN WINBERG, Project Secretary at the National Social Welfare Board). The ARBETSPLAN is used in education and extentional training of the preschool staff. The science education section of the ARBETSPLAN is, in itself, not the object of any study.

The School System

The work of the commissions and other projects all share the aim of securing better quantitative results from school activities. The work of the Royal Commission on the School, the State and the Municipalities (SSK) (SOU 1974:36) was mainly concentrated on three things (TEVEBORG, See SOU 1974: 36):

- measures concerned with changes in the school environment and working conditions
- measures concerned with changes of course content and course disposition, and
- measures concerned with the allocation of responsibility for organization, resources and administration.

The work of SSK was predominantly concerned with the latter.

The proposals of the Royal Commission on Working Conditions in Swedish Schools (SIA) (SOU 1974:53 & 58) can be summed up as follows:

- The introduction of "an integral school day" with fixed and free activities. Design and content of the school day to be prescribed by the local education authority.
- Flexible allocation of resources.
- Altered forms of work. Work in work teams leading school work, and with teaching groups of varying size and composition.
- Contact school - community. Contacts between school, home, organizations, institutions, occupational life etc.
- Widen possibilities, and new forms of decision-making on the local level.

The School debate was stimulated in particular during the period of circulation for comments on the SIA-proposal of The Royal Commission on Working Conditions in Swedish Schools (SOU 1974:53 & 58). A project within the Board of Education

on problems concerning aims and evaluation also contributed to the discussions (MUT, 1973 and ASÖ, 1974). A reorganization took place at the Board of Education on July 1, 1972, and a department of education (department S) for the whole school sector was created. The MUT-project ('Målbestämning och Utvärdering' (Determination of Goals and Evaluation)) was initiated within department S. The work was coordinated with two earlier National Board projects: LUG (Läroplansuppföljning i grundskolan (Continuous Observations of Curriculum in the 9-Year-Compulsory Comprehensive School) and LAGY (Läroplansarbetet i gymnasieskolan (Curriculum Work in the Integrated Upper Secondary School)).

"Goals and principal items laid down by the Government and the Riksdag (The Swedish Parliament) indicate the framework within which teaching is to be conducted. Within the framework, the curricula give the teachers a great deal of liberty - in collaboration with their pupils - to plan and conduct their teaching. At the same time it is the task of the National Board of Education to amplify the goals and principal items by means of supplementary instructions, comments and examples." (TEVEBORG, See SOU 1974:36).

It is the task of the Board of Education to superintend education so that content and methods are continuously renewed, evolved and improved. Within the LAGY project, courses of study were elaborated for the supplementary parts of the integrated upper secondary school core curriculum, the 3-year natural science line (N) and the 4-year technology line (T).

In biology (N) the course of study was tested during the school years 1973-1976. It is influenced by the American project: Biological Science Curriculum Study (BSCS). We refer to the study by a group within the Board of Education (SÖ-GRUPP I BIOLOGI, 1976).

The final version was decided on in May 1976 and can be used as an alternative beginning with the school year 1976-1977. The announcement of the biological course of study was published in: "Current News from the Board of Education" (Aktuellt från Skolöverstyrelsen (ASÖ) 1975/76:47).

The chemistry (N & T), the final version of the course of study (May 1976) can be used beginning with the school year 1976-1977 in N & T, grade 10. Experiences from the Swedish LABUPP project (LINDBERG, 1972) were included. The teachers are invited to partake in the further evaluation of the cource of study in chemistry.

As an interim measure, a new course of study in physics (N & T) was decided on in May 1976. The plan is to introduce this preliminary course of study in the school year 1978-1979. Experiences from Swedish experimental activity with the PSSC (Physical Science Study Committee) and the Swedish project on Physics within TRUAS' experimental activity (Kommittén för television och radio i utbildningen (TRU) (The Committee for Television and Broadcasting in the Education)) were taken into consideration. PSSC experimental activity will be concluded in the school year 1978-1979 starting in grade 10, N-line. It will be possible to introduce experimental activity with the new course of study in the school year 1976-1977 if the subject conference on physics decides to do this at the school in question (GÖRAN LINDAHL, educational consultant in physics at Division S3).

In the LUG project, members discussed problems and suggested measures. It is their task to illustrate the so-called "experimental" or inquiring way of work and to make it tangible basing the work on the pupil's starting point. The present form of education is characterized by a lot of content and by too many theoretical elements. The problems mentioned and other problems in the current debate were published by the National Board of Education (ASÖ 1975/76:42). In this number of "Current News from the Board of Education", guidelines for a review of curriculum in the 9-year compulsory comprehensive school are given. The guidelines were accepted

by the Board of Directors of the National Board of Education. The document is closely connected to the GOVERNMENTAL BILL 1975/76:39 on Working Conditions in Swedish Schools (SIA).

A Board Project (Division S 6) with implications for science education is the Sex Role Project (VESTIN, 1975 a,b c,d). Sex differences in science achievement have been studied by the International Project for the Evaluation of Educational Achievement (IEA) (COMBER & KEEVES, 1973 and HUSÉN et al, 1973).

In the GOVERNMENT BILL 1976/77:39, it is emphasised that educational work in the preschool and the 9-year compulsory comprehensive school must be given a holistic pattern, in which the starting point for educational work is the child's self conception, his concept formation and his ability to communicate. Attention is drawn to educational models proposed by The 1968 Child Centre Commission (SOU 1972:26) and in particular the model which accentuates the relationship of man and his environment. It is much more important that the pupils are able to master basic knowledge and skills than that they have gone through, with more or little retention, the whole curriculum and all the educational materials. Basic skills such as the ability to read, write and calculate, ought to be taught in other subjects besides Swedish and mathematics. At the same time, methods in the 9-year compulsory comprehensive school must be oriented towards more practical and "experimental" forms of work.

The University and the Teacher Training College

It was the task of The 1968 Educational Commission (U68) (SOU 1973:2 & 3) to propose the volume, localization and organization of the basic training of post-school education. The teacher training college will be integrated in the new university organization "Högskolan" beginning in the fiscal year 1977/78. Educational aspects were not the primary aim of U68. With regard to the central role of these questions, U68 discussed the goals for educational contents and forms

of work. Three dimensions were considered: the field of application of education, skills and knowledge, and problem orientation.

The Pedagogic Commission (SOU 1970:22) proposed research training in subject methodology. Experimental activities using this research training have begun in the subjects physics and mathematics (also English and German). Professors KJELL HÄRNQVIST and KARL-GUSTAF STUKÄT (at the University of Gothenburg and Mölndal School of Education) were members of the Commission. The Office of the Chancellor of the Swedish Universities has - in consultation with the National Board of Education - sanctioned syllabuses for research training in education with subject methodology oriented towards the discipline in question. At the University of Gothenburg, HÄRNQVIST and STUKÄT are supervisors (the syllabuses were sanctioned in April 1974). The Swedish doctoral degrees in education with behavioural science orientation and with subject matter orientation (experimental activity) were discussed by HÄRNQVIST (1974). Experimental activity on research training in subject mehodology has resulted in a first dissertation, a thesis in the field of physics (see Note 1). BJÖRN ANDERSSON (1976) defended his thesis on Science Teaching and Development of Thinking at the University of Gothenburg, December 4, 1976. The work was carried out within the framework of the LMN-project (see Note 2) at the Mölndal School of Education. In Gothenburg we have one doctoral student in mathematics and another one has been reported at the University of Linköping. We wish to note that two persons have obtained official permission to partake in experimental activity in biology at the University of Gothenburg. A doctorate qualifies for the appointment as senior master (authorized by the National Board of Education at the end of 1974).

The above-mentioned commissions all reflect the demands of society on the educational systems. The 1969 Core Curriculum for the 9-year compulsory comprehensive school and the 1970

Notes 1 and 2 appears before the references at the end of this report.

Core Curriculum for the integrated upper secondary school have, for quite selfevident reasons, not been reflected in all teacher training. The changing conditions have strengthened the need for a new look at teacher training. Primarily, it is the task of The 1974 Teacher Training Commission (LUT 74) to work on questions concerning goals, structure, content and internal organization of the basic training of all categories of school teachers. The starting point is the changing role of the teacher. LUT 74 published a paper (LUT, 1976) with the title "Teacher Role - Teacher Training". The paper is part of a current study. The aim of the Commission is to initiate a discussion among interested parties. LUT 74 has seen the following possible trends for change in the school:

- Widening of responsibility.
- Changing pupil role.
- Changing process learning.
- More open school.

It is the task of LUT 74 to consider a recurrent extentional training based on a proposed basic training.

REPORTED RESEARCH PROJECTS ON SCIENCE EDUCATION

Sources

Substantial R & D projects are reported in the following publications:

- 'EDUCATIONAL RESEARCH IN SWEDEN' (1971-72 & 1973-74)
- 'SWEDISH BEHAVIOURAL SCIENCE RESEARCH REPORTS (1973-74 & 1974-75)
- 'SVENSK UTBILDNINGSFORSKNING' (1974 & 1975) (Swedish Educational Research) FoU-katalog (1974) (R & D Catalogue)

Research reports and higher examinations studies published at institutes of education at universities and teacher training colleges are listed in BJERSTEDT (1975 & 1976), cove-

ring the years 1969-74 and part of 1975.

Divisions S 3 and L3 of the Board of Education initiated a survey of research and developmental work within the sector of natural science in the school (LYBECK, 1975). It covers the period 1964-1974. The purpose was to get an idea of R & D projects beyond the direct influence of the Board of Education.

In fact, several finished, ongoing and newly started R & D projects are reported. The projects reflect the changing conditions in the educational system. We have to conclude that projects to be classified as research into science education are a small part of the sector of research in education. On the other hand, there are a lot of D-projects covering science education.

The Preschool System

The Gothenburg Preschool Project was initiated by Professor KARL-GUSTAF STUKÅT at the Gothenburg (Mölndal) School of Education. The project, which was sponsored by the National Board of Education, started prior to - and independent of - The 1968 Child Centre Commission (SOU 1972:26 & 27). Two members of the preschool project, KARL-AXEL SVERUD and OLOF ERNESTAM, were experts in working groups connected with the Commission. Preschool Programmes in Sweden and the project mentioned have been described by STUKÅT (1974). STUKÅT & SVERUD (1974) have summed up the project as follows: "The purpose of the project has been to develop new learning methods and materials concentrated on goals and areas related to social, language and concept development. Within each of these, objectives have been analysed and formulated in concrete terms. As to its methodological character, the programme can be described as learning-oriented and moderately structured with emphasis on the dialogue pattern of interaction between teacher and child. The experimental programme was field-tested for a period of one year in 24 preschool groups of 438 children."

The project used material developed by the American project SCIS in the training of natural science concepts. "The evaluation took into consideration educational processes as well as the effects of the programme. The purpose of the evaluation was to study social interaction in groups, children and teacher attitudes, learning effects, and the practical feasibility of integrating experimental activities into the entire preschool programme." "The instruction given to teachers as preparation for the experimental programme was thought by the teachers to be valuable in-service training. It was concluded that this training makes as important an impact as the new material and methods introduced. As a consequence, a new project focussing on preschool teacher training has been started."

We have not found any preschool project closer to the defined aim of this survey than the Gothenburg Preschool Project. There are, of course, many R & D activities within the preschool which were begun in 1974 and will be completed in 1978 at Mölndal School of Education and which were sponsored by the National Board of Education. The project- and investigation head is Professor STUKÅT.

Professor BENGT-ERIK ANDERSSON (1976) at the Stockholm School of Education has described the activities and orientation of their research group.

The School System (see Note 2)

The project "Models for the Adaption to Individual Differences" (MID-project) was financially supported by the National Board of Education and carried out at the Institute of Education, University of Gothenburg. The scientific head of the project was Professor KJELL HÄRNQVIST. The project started in July 1971. In May 1976 a member of the project defended a doctoral dissertation on "Verbal and Figural Aptitudes in Relation to Instructional Methods. Studies in Aptitude-Treatment Interaction" (JAN-ERIC GUSTAFSSON, 1976). Two empirical studies, in which the effects of verbal and figural instructional materials are compared for pupils with different aptitudes were described. The subject matter taught

was: the polar lights, and the heart. The subjects were pupils from grades 5 and 7 (ages 12 and 14 years) of the 9-year compulsory comprehensive school. The readers may refer to GUSTAFSSON (1976) for more detailed information. The IBID-project is the continuation of the MID-project. Two researchers are employed.

The project "Creative Development" was financially supported by the Swedish Council for Social Science Research and was carried out at the Institute of Education, University of Gothenburg. The scientific head was Professor KJELL HÄRNQVIST. BJÖRN SANDGREN (1974) defended the doctoral dissertation "Creative Development. An Empirical Study of Cognitive Development and a Critical Analysis of the Concept of Intelligence". We quote from an abstract: "The second part reports an empirical study of certain aspects of cognitive development in children between the ages of 11 and 16 years (grade 4-9). The purpose of the empirical study has been to develop instruments of cognitive variables in order to create a base for developing alternative methods. The final section is an analysis of the formal educational system's influence upon cognitive growth. Development via specialisation is contrasted with creative development. The analysis comes to the conclusion that the formal education system, by virtue of the form which the evaluation of outcomes has received, tends to separate the process of knowledge accumulation from cognitive growth."

As a consequence of the above mentioned project, Assistant Professor BJÖRN SANDGREN is project- and investigation head of the project "'Project' Learning and Cognitive Development" (sponsored by the National Board of Education, July 1975 - June 1978). It is the aim of the project to work out methods for active knowledge acquisition (project learning). The work is to be carried out together with teachers closely related to ordinary school work. Another aim is to construct instruments and methods for measuring cognitive development.

An anticipated result is a change in the basic educational view expressed by a switch of interest from the educational product to the educational process. The experimental activy is concentrated on grades 7-9 of the compulsory comprehensive school of the school year 1976/77. During the school year 1975/76, the experimental activities were conducted at the junior level (grades 1-3), at the middle level (grades 4-6), at the senior level (grades 7-9), and at the teacher training level. The project is in accordance with the theories behind the SIA-proposal. The project employs 2.5 researchers.

The project "The Validity of Piaget's Model of the Development of Logical Thinking" was carried out at the Institute for the Study of International Problems in Education (IEA), University of Stockholm, and sponsored by the National Board of Education. The project head defended (December 1974) his doctoral dissertation (degree of Doctor of Theology) on "The Development of Hypothetical Deductive Thinking in Children; a Cross-Cultural Study of the Validity of Piaget's Model of the Development of Logical Thinking" (KURT BERGLING, 1974). We quote from an abstract: "An empirical study of both the concurrent validity of the model and of the development of hypothetical deductive thinking proposed by JEAN PIAGET was conducted by applying this model to items from the IEA Six Subject Survey. The sample size was 918 Swedish boys, 880 Swedish girls and 1 110 Hindi-speaking Indian boys. All the children were 10-11 years old. The results confirm the basic proposition of the Piagetian theory - that is, that the development of thinking follows a predetermined fixed sequence of stages; and a cross cultural comparison between Sweden and India confirms that the pattern is the same in both countries except from variation in rate. It is demonstrated at the outset that item analysis data derived from multiple-choice items can be used in testing the validity of the Piagetian model of the development of thinking: that is, to predict answers in a meaningful way. Different methods of test construction based on the Piagetian theory were tried out. All scales and tests correlated higher with school

achievement, as measured by the science test (IEA/1A, 1B) than with two IEA verbal intelligence tests (IEA/3C, 3D). This was interpreted as indicating that the Piagetian theory describes some type of "scientific" intelligence, rather than "verbal" intelligence and that measures of this "scientific" intelligence are of importance to predict performance in school." In the so called MOGNAD-project (1976) Bergling has made use of Bergling's Reasoning Level Test.

At the Institute for the Study of International Problems in Education (IEA), University of Stockholm, COMBER & KEEVES (1973) reported on an empirical study of science education in nineteen countries. Based to some extent on this study, HUSÉN (1973) and his Swedish collaborators published a study on natural orientational subjects in Swedish schools seen in an international light. These studies contributed to the discussion on the Swedish educational system.

At IEA, KIFER, MATTSON & CARLID (1975) applied the Rasch model according to WRIGHT on the science test items of Population II in Sweden. The test has 11 items in common with the Population I test and 20 items in common with the Population IV test. A comparison between the scores of students in Population II indicates that a selection mechanism has operated to put low-scoring science achievers in the Fackskola (the 2-year integrated upper secondary school, grades 10-11 (ages 16-17)) while the higher scoring students tend to go the Gymnasium (integrated upper secondary school, grades 10-12 (ages 16-18)). The authors have attempted to scale some "affective" items from the IEA questionnaires with some success. They have suggested the application of the Rasch model in the new IEA Mathematics survey to obtain measurements of the "old" mathematics study and the "new" one.

The LMN-project was a D-project for improving science instruction at the junior and intermediate level of the Swedish nine year compulsory school based on the American SCIS-project. The LMN-project (Låg- och Mellanstadiets Naturvetenskapliga undervisning) started in 1968 and was completed in July 1976 (Mölndal School of Education) (see NR, 1974 and

Lundeberg & Norén, 1975). The project was sponsored by the Board of Education. Teachers from the departments of Physics, Chemistry, Biology, Educational Research, Junior Level Teaching and Intermediate Level Teaching have been members of the LMN-staff. Assistant Professor Nils Svantesson, Department of Physics, was the project head. Dr. Björn Andersson has served as assistant project head.

Within the framework of the LMN-project Björn Andersson carried out the work on his thesis (ANDERSSON, 1976) in the field of science education. Mainly with respect to conceptual development, ANDERSSON (1976) has studied a limited part of the SCIS/LMN programme, viz. the unit "Relativity". The concepts of position and reference object are basic. He put the following questions:

1 Does "Relativity" develop the pupil's ability to coordinate perspectives?
2 Does "Relativity" develop the pupil's concepts of left and right?
3 Does "Relativity" develop the pupil's ability to describe the position of an object? (See Note 1)

ANDERSSON (1976) has contributed to the development of training studies within the framework of the Piagetian system.

Project IANO (Inlärningsstruktur och arbetssätt i naturorienterande ämnen (Learning Structure and Form of Work in Natural Orientational Subjects)). The project started in July 1975 and was planned to be completed in June 1978. It is sponsored by the National Board of Education and administrated by the Department of Education at the Teacher Training College in Umeå. Professor STEN HENRYSSON is the scientific head and SVEN JANSON is the project head. JANSON was a lecturer in Methods (Mathematics and Physics) at the College. He is, at present, a lecturer in education there (see JANSON, 1975). The third researcher is the Senior Master (integrated upper secondary school) Dr. (fil lic) KJELL GISSELBERG. He is a physicist.

GISSELBERG communicated the following: "The project employs two research workers. The main field of the project is science education in grades 7 to 9 of the upper primary school (the age of the students ranging from 14 to 16). The aim of the project is to investigate if student-centered, problem-oriented methods of teaching help to fulfill the aims and objectives of the national curriculum. Two problem areas can be identified. The first is the initiation of teaching methods which focus on the student's interests, and problems in science. This is hopefully done by introducing teachers to different psychological and educational theories and deducing adequate methods of teaching from these. The second problem area is the development of suitable methods of evaluating the aims and objectives of the national curriculum. Ordinary types of cognitive tests will be used but also interviews and questionnaire techniques will be employed."

BMN-project (Begreppsbildning inom matematik och naturvetenskapliga ämnen (Gymnasieskolan) (Concept Formation in Mathematics and the Natural Sciences (the integrated upper secondary school)). The project started in July 1975 and was planned to be completed in June 1978. It is sponsored by the National Board of Education and is being carried out at the Institute of Education, University of Gothenburg. Professor FERENCE MARTON is the behavioural scientific expert. LEIF LYBECK is the project head. LYBECK is an oceanographer (Ph.D.) and Senior Master in mathematics and physics (the integrated upper secondary school). He has been a lecturer in Methods at the Gothenburg School of Education and has been commissioned to do some studies for the National Board of Education (LYBECK, 1972,1973,1974 a, 1974 b, 1975). Some of these studies use the theory of science as a basis. (University of Gothenburg (R D T S, 1974)).

The aims of the BMN-project are:

- To examine the effect of educational content on concept formation and, with concentration on grade 10 (age 16), to widen understanding of natural science concept formation and its relation to mathematical concept formation. (The concept

of pressure was cosen as the guideline. The concept of pressure is quantified by models using mathematics as an instrument.)

- To ascertain the variation of the subjective conception of the pressure concept and related concepts for different ages and to work out an analysis method adapted to science education with regard to behavioural scientific aspects.
- To provide an empirical background to a suggested outline of an educational theory for a natural scientific way of working (LYBECK, 1973, 1974 b), for the purpose of working out a method of teaching science.
- To apply the Rasch model (LYBECK, 1974 a).

The work of the BMN-project is closely connected to the research done by the Group of Learning and Cognition. Its scientific head is FERENCE MARTON, who is also a specialist on evaluation. The group's view of learning has recently been described by MARTON (1975, 1976). It is sufficient here to give two quotations. "As far as the learning-teaching level in higher education is concerned, we must identify the basic concepts and principles in various academic subjects and describe the variation in how these concepts and principles are understood or misunderstood. In this way we can discover both what the individual acquires and what he fails to acquire. The idea is simple enough: in order to help the students understand, we must first understand their way of thinking about the topics with which we are concerned. (MARTON, 1975)" & "The developmental psychologist Heinz Werner has, like other researchers, emphasized that cognitive development from childhood to adulthood in western civilization is characterised by an increasingly abstract and strongly systematized conception of the world around the individual (Werner, 1957). This process of abstraction means that we perceive different aspects of the same phenomenon which we then regard as constituting separate categories of thought. These categories can then be treated one at a time, as it were. In this paper, we have consistently argued against see-

ing these separate categories of thought as representing separate phenomena.

General concepts, for example, often represent deeper aspects and not independent entities. In our opinion, the relation between skills and knowledge is the same. The problem with abstraction is that we can no longer see the phenomenon, which we have divided into different subaspects, as a whole (MARTON, 1976)".

Contributions to the above perspective on how concepts evolve in the natural sciences have been provided by the University of Gothenburg, based on the theory of science and on the history of science (LYBECK, 1973, 1974 b). The first period of the starting year 1975/76 began with a study of the historical development of the pressure concept and related concepts viewed from the prespective of theory of science. This background was of great value during the individual interviews with the students carried out by the project head. These interviews are now analysed by a member of the group, ROGER SÄLJÖ, Ph.D. in education. Integration of knowledge of the same territory is being attempted as far as possible (Lybeck, Marton & Säljö, 1976).

A large number of classroom and laboratory activities have been tape recorded during the school year 1975/76. These data are at present being analysed by the experimental teacher and the project head. They provide the possibility of studying individual students' understanding of the concepts in a time-perspective. The individual interviews provide complementary information.

I would like to make my own experiences known regarding the question of exchange of information in the scientific community with respect to science education and the BMN-project. During 1971, the concept of integration in relation to science education was strongly debated in Sweden. The reason was mainly the conditions in the integrated subject general science (naturkunskap) introduced into the 2-year, respectively the 3-year, lines of the integrated upper secondary school. In LYBECK (1972), I brought together some relevant

material and gave critical viewpoints based on a platform of theory of science. The work was published as Arbeitsberichte 3 at the IPN (Institut für die Pädagogik der Naturwissenschaften, Kiel) and was used as a background paper at the "4. IPN-Symposion". The above-mentioned work (LYBECK, 1974 a) is a literature study of the Rasch model. I partook in the "IPN-Seminar 1" (Das Modell von Rasch und seine Anwendung in der Unterrichtsforschung) with Dr. HANS SPADA as chairman of the course. At the time, and later on, Dr. SPADA generously gave me information on his work. As regards the Rasch model, Drs. WOLF HEYNER, PETER HÄUSSLER and WILHELM F. KEMPF also taught me and sent me information. Prof. GERHARD H. FISCHER and Dr. ISLE ROP at the University of Vienna helped me to obtain scientific reports. Professor ERLING B. ANDERSEN and Dr. JON STENE at the University of Copenhagen kindly sent me their own works and work done by Professor GEORG RASCH. I have benefited from this help and wish to express my sincere thanks to all. I am trying to utilize my experiences from the "7. IPN-Symposion" on formalized theories of thinking and learning and their implications for science instruction in the BMN-project, and in particular in the development of the Rasch model. Dr PETER ALLERUP sent his EBA-program to me recently and I thank him for his kindness. Dr. HÄUSSLER at the IPN made use of the experiences from the "4. IPN-Symposion" and gave, at the "5. IPN-Symposion", a critique and new viewpoints on integrated science projects. I have referred to his studies in LYBECK (1974 b). In that paper I argue for the need of a theory of science in science education. Some points of view behind larger international curriculum projects were criticized. If the ideal picture of the child as "the small scientist" is accepted as "a didactic concept", there is an analogy between, on the one hand, the pupil and the teacher, and on the other hand, the scientist and his counterpart within the theory of science. As regards the platform on theory of science in Gothenburg, this analogy is relevant to the teacher role and the pupil role. The theory of science can give us humanistic knowledge of a kind not much

known among the teachers. Of course, this knowledge must be integrated with knowledge from developmental psychology etc.

As to the question: "How are teachers exposed to the results of research?", I use my own experience as an example. During the years 1972--1975 the papers by LYBECK (1972, 1973, 1974 b, 1975) were used in the extentional training of general science teachers. These courses were held one week every summer and were sponsored by the National Board of Education through the In-service Training Institute. The material is used on teachers' study days. Study materials have been put together for further study days at the initiative of the Institute. It is intended that the teachers who partook in the summer courses will conduct local study days.

The University and the Teachers Training College

There are no reported or planned educational research projects on science education at university level. There are, however, several D-projects carried out in cooperation with the PU-enheten (the units for educational development work at the universities). The project "An Attempt to integrate within a 'block subject' (Biology)" started in 1974/75 at the Biological Training Laboratory (Biologiska övningslaboratoriet), University of Lund. This project is an attempt to realize an integration within the subject area biology taking into consideration the demands of the subjects, the research and society. Some preliminary results from this D-project and other projects discussed during the PU-day in April 1976 were reported by GERTRUD NORDBERG-DAHLGREN & BÖRJE KARLSSON (1976).

A very interesting investigation, concerning the "Development of Methods for Planning of Instructions" was started in 1974/75 sponsored by the University of Lund, the Office of the Chancellor for the Swedish Universities and AB VOLVO (a car manufacturer). Assistant professor BENGT KJÖLLERSTRÖM carried out the study as a participating member of the section for technical development at AB VOLVO. Based on his own experien-

ces as a working member of concrete developmental projects and on interviews of employed physicists, KJÖLLERSTRÖM (1976) reported some conclusions as regards the planning of physics education at the faculty of arts and sciences in relation to what is wanted by commerce and industry. In addition, KJÖLLERSTRÖM was project head in a number of D-projects. BENCKERT, GABRIELSSON & NORDHAGE (1975) reported on a D-project "Non-specific Goals in Education and Examination on C 1-course Level Physics". The project started in 1974/75 at the Physics Department, University of Umeå. A problem-oriented approach was used.

At a conference held recently in Bremen, SVEN WESTMAN (lecturer at the University of Stockholm, Arreniuslaboratoriet, S-104 05 Stockholm) reported on "A Project- Oriented Course in Inorganic Chemistry at the University of Stockholm". WESTMAN has conducted several D-projects. He is one of the initiators of the so-called SPUCK conferences. The SPUCK III conference will take place from August 16-19, 1976 with more than 110 participants, mainly university teachers of chemistry. Many projects were reported on and several educational themes concerning chemistry education at university level were discussed in working groups. Assistant Professor WANDA MARK (Chalmers tekniska högskola, S-402 20 Gothenburg) was the chairman of the organization committee. The results of the SPUCK III conference will be edited by WANDA MARK.

The KUL-Ä-project (Kvalitativ utvärdering av lärarutbildningen, ämneslärarlinjen (Qualitative Evaluation of the Training on Secondary School Teachers)) Scientific head: Professor SIXTEN MARKLUND and project leader: THORD ERASMIE.

The project was described by ERASMIE & MARKLUND (1974). We quote: "The KUL-Ä-project at the Linköping School of Education, Sweden, studied the one-year training at the college of education of secondary school teachers coming from the university with an academic degree. The present report deals with teacher trainees of mathematics, physics, chemistry and biology who were trained in 1971--72. The study focussed on three aspects of the training programme: Educational Psychology, Methodology and Teaching Practice. The results of

various tests and questionnaires are presented and discussed. The report ends with a number of recommendations."

TRENDS IN RESEARCH IN SCIENCE EDUCATION

Based on Government Commissions, the Riksdag and the Government have decided on the main direction for future research in science education. It is the task of the Boards and other interested institutions etc. to elaborate measures. As background material for this work we would like to mention the studies on tendencies in educational statistics during recent years (SCB 1974 a, 1974 b), the report on the Swedish population according to level of education 1970--2000 (SCB, 1975 a) and Swedish university education I (SCB, 1975 b).

The School System

At the end of 1972 the National Board of Education organized an N-group with the task to study problems and suggest measures to find solutions connected with mathematics and natural science education. According to the Government Budget Proposal 1973:1, Supplement 10, the Board was commissioned for this task. In Government Budget Proposal 1975/76:100, Supplement 10, the Minister of Education mentioned the Board Programme of measures and said that the training capacity ought to be maintained in the natural science line (N), the technology line (T) and the economics line (E) of the integrated upper secondary school. During a 5-year period, the recruitment to the N-line decreased by 30 % (1971, 10 486 students, 1975, 7 748 students). Recruitment to the T-line was fairly stable during the same school years (around 6 500 students). The so-called "flight from the N-line" among other things to the social science line (S), has decreased the rate of flow of students through the N-line to 65 % (LUNDBERG & NORÉN, 1975).

One student out of three in the N-line interrupted his studies or changed line compared with one out of six pupils in the other lines (the lines are E, S, N, T and the H-line, the liberal arts line). The basis for recruitment to faculties of natural sciences and institutes of technology are

the N- and T-lines. About 75 % of the students come from the N-line and about 25 % from the T-line. During the last 5 years the flow of students to the faculties of science has decreased by about 60 %. The training of graduate engineers suffers from the lack of students in the N-line. As to common problems, serveral of the N-group's members belong to cooperation groups in mathematics, biology, physics and chemistry organized by the National Board of Education and the Office of the Chancellor of the Swedish Universities. In these groups, they have discussed among other things courses of study and in-service training of teachers. On several occasions the N-group has held discussions with labour market representatives. The N-group's activities and measures have been described by LUNDEBERG & NORÉN (1975).

The N-group initiated a survey of R&D-projects within the sector of natural sciences at the school (LYBECK, 1975). During March 1974 the Head of Division 3 (LUNDEBERG) sent a questionnaire to the institutes of education at the universities, the country boards of education, the teacher training colleges and the experimental schools of this colleges, the municipal experimental educational areas and - for information - to the heads of the departments of biology, chemistry, nature studies and physics at the teacher training colleges. All of them answered the questionnaire[1]. The survey points to the fact that several studies have been carried out by institutions and individuals. A lot of the reported D-projects are used in the in-service training of teachers (all school levels). At the Linköping School of Education, NILS NORLIND (lecturer in methods, physics) is conducting a D-project integrated with the training of teachers on "Tasks measuring laboratory skills". At the integrated upper secondary school in Sundsvall, STIG GRANQVIST

---

1) In this way about 40 % of the references were obtained. Some of the references were taken from the original studies done earlier by Board Projects, namely, LAG and ARUNA. Articles and studies connected with the answers were added. The viewpoints behind the survey have been mentioned. The completions and the thoughts have been guided by a platform of theory of science (LYBECK, 1975).

has conducted an analogous D-project and other projects (LYBECK, 1975). GRANQVIST (assistant master, physics and nature studies) is still conducting several D-projects. He is a good example of an individual making improvements in science education at school level. At the Department of Physics, Gothenburg School of Education, BJÖRN ANDERSSON (1973) carried out the study "Some Simple Experiments Illustrating School Children's Entry into the Stages of Formal Operational Thought" with implications for grades 7-9. Several of the D-projects are on the borderline between research and development. This is the case as regards the first-mentioned projects. ANDERSSON'S study must be classified as a research.

Without any priority claims, the survey (LYBECK, 1975) gave evidence for R&D-projects in science education in the following areas.

- Development of subject didactics and/or subject methodology.
- Concept formation in natural sciences (biology, chemistry, nature studies and physics).
- The model in natural sciences education.
- Theories of natural sciences education.
- Experimental (laboratory) skills.
- The influence of the way of work on the effect of science education.
- The relation of the subject content to social, commercial and industrial life.

The survey on R&D-projects (1964--1974) was sponsored by the Division for Educational Research and Development Work (L3:1) at the Board of Education. Section L3:1 arranged a Conference on Research and Development Work regarding General Natural Subjects and Natural Science Education in Youth Education. The Conference was held at the National Board of Education on April 3-4, 1975.

The Conference Report has been edited by GISSELBERG (1975). Fifteen persons from Divisions L3, S1, S2 and S3 of the Board - mainly members of the N-group, and 30 persons from

Teacher Training Colleges, Schools or Country Boards of Education - were invited to participate[1)]

At the conference SÖREN LEVÉN (consultant at S1) presented studies in progress concerning 9-year compulsory comprehensive school (see ASÖ 1975/76:42) and LUNDEBERG reported on the work of the N-group and related works concerning the integrated upper secondary school. In the third opening talk, KJELL HÄRNQVIST put forward three themes, namely, the situation of subject methodology research, problems related to findings within the MID-project (see above and GUSTAFSSON, 1976) and the recruitment to natural science subjects. With regard to the first theme, HÄRNQVIST advocated teamwork during the process of research, where the educationalist and the subject methodology expert would be able to cooperate from the very start of the project. He gave two examples from the Institute of Education, University of Gothenburg, in which the significance of the subject structure and the subject content for learning are considered. One of the groups is the PUMP-project (Professor ULF LUNDGREN and project head, M.Sc. WIGGO KILBORN) working on arithmetics. The Group of Learning and Cognition is the other "content-oriented" research group, which has worked on problems within university pedagogics, mainly in political economy. The above-mentioned BMN-project has integrated its research with this group. At the Conference on R&D, the working groups devoted their time to one of the following themes:

- Concept formation and subject matter.
- Basic skills in the 9-year compulsory school and central concepts.
- Models in education.
- Didactics.
- R&D concerning goals for natural science education.
- Ways of working.

---

1) The survey (LYBECK, 1975), the plans of the projects IANO (SVEN JANSON, see above) of the BMN-project (LYBECK, see above) and of a project on "Level of Concept Development and Natural Scientific Learning on the senior level of the 9-year compulsory comprehensive school" (BJÖRN ANDERSSON), and some proposals were sent as background material.

In addition to the limited grants of the National Board of Education for R&D in science education, the following resources were listed in one of the groups:

- Lecturers in subject methodologies (at Teacher Training Colleges).
- Experimental schools (at Teacher Training Colleges).
- In-service training consultants, educational advisers and upper secondary school inspectors.
- Institutes of education at the universities.

The results ought to influence:

- Teacher Training.
- In-service teacher training.
- The development of educational materials.
- The allocation of resources for further development work.
- The current review of curriculum.
- The work at teacher training colleges and at institutes of education.

In the survey of R&D, the present author argued (LYBECK, 1975) for the necessity of an integration on the theory of science and development psychology in research into science education.

During the final discussion of the Conference LARS DAHLSTRAND (lecturer in subject methodology at the Mölndal School of Education) recommended cooperation, on the one hand, between people trained in theory of science and in subject methodology and, on the other, between trained people in subject methodology and developmental psychology. He said that the theory of science is trying to study structures and patterns in different disciplines. At present there are no studies on subject methodology in print in Sweden. The purpose of the theory of science approach is to compare the subject methodology with the patterns within other sciences (not necessarily a natural science).

The N-group (LUNDEBERG & NORÉN, 1975) has given high priority to projects within the following areas:

- To survey the needs of the society for people educated in the natural sciences.
- To investigate how attitudes to, and interest in, natural science subjects and technology are created, especially in girls.
- To analyse methods of education supporting concept learning.
- To inquire into the educational and methodological implications of the use of pocket calculators in education.
- To investigate how computers and programmed table calculators affect education.

Here, I can only point out that the N-group has proposed several measures beside R&D. Some more important D-projects are discussed by LUNDEBERG & NORÉN (1975).

The University

It was the task of a working group at the Office of the Chancellor of the Swedish Universities to propose measures for the future organization of training within the faculty of science to achieve a more pronounced orientation towards occupational life. It was also the task of the group (NATURVETARGRUPPEN, 1976) to initiate and support such a development of the syllabus, and design training to make the students well-qualified for tasks within established functions as well as within new functions in society. The group suggested that the N-line in the integrated upper secondary school ought to be reformed.

NATURVETARGRUPPEN (1976) proposes that the resources for educational developmental work be used more exensively for cooperative studies between universities and commercial and industrial life (Example: KJÖLLERSTRÖM, 1976). The group points out that it is urgent that experiences from experimental activities are taken into consideration. The group suggested that interaction should be a part of the extended training of university teachers. It has discussed the need to renew the methods in training based on development studies.

An obvious element in the subject matter of training ought to be a development of creativity. The group strongly emphasized educational development work.

The R&D-units of the Office of the Chancellor of the Swedish Universities has arranged a conference on "Concept Formations and Knowledge Acquisition within Some Disciplines (Mathematics, Political Economy, Physics and Statistics)". 10-12 persons were invited to participate in each of the subject groups. They represented the subjects at university level and other subjects such as theory of science, philosophy, education, sociology and psychology. The conference was held on June 2-3, 1976. The purpose was to analyse problems and difficulties concerning the teaching and learning of the central content of some subjects in basic university training.

The Physics Group recommended the following outlines for research projects:

- Theme: How does the student change his ability to learn during the educational process?

  Limitation: What are the student's conceptions of different concepts? How does this conception change during training? A case-study on the changing concept formation and concept learning of some students during the training period.

- How do the physics teachers themselves look upon the relation THEORY - MODEL - EXPERIMENT - REALITY?
  The problem is essential, as we consciously or unconsciously transfer our view to the students.

- What happens to the mathematical concepts, when they are incorporated into physics?

<u>An outline for a research project</u>

The changing conditions in society make great demands on science teachers (see the commissions). The teachers are not trained for the changing teacher role and the changing pupil role. It is no longer sufficient to be trained purely in science. The humanistic aspects of science are lacking in training at university level. I refer to such disciplines

as the theory of science and the history of science, which study the creative processes and the products of science. The products are reported in papers and transformed into textbooks etc., but the processes are seldom made explicit in educational materials. The history of science and the theory of science provide us with knowledge and understaning of these processes in relation to the products. If the teachers are not exposed to a training within the history of science and the theory of science, it does not mean that they do not have an insight into science. However, the problem is that this insight is not articulated and consequently cannot be the object of self-criticism.

I am strongly in favour of a research project considering the whole educational sector and inquiring into the teachers' conceptions of knowledge, knowledge formation and learning, and what, how, when and why they transfer these to the pupils, and the pupils' conceptions of the same fields. I am firmly convinced that the theory of science can give a valuable contribution to these problems. I consider such a project urgent and I hope that the results will implicate in general a qualitative improvement of science education at all levels of the educational systems. In the integrated disciplines such as subject didactics and subject methodology, the theory of science has an obvious role to play.

NOTES

Note 1

Mainly with respect to conceptual development, ANDERSSON (1976) studied a limited part of the SCIS/LMN programme, viz. the unit on "Relativity". The concepts of "position" and "reference object" are basic. ANDERSSON (1976) put the following questions:

1 Does "Realtivity" develop the pupil's ability to coordinate perspectives?
2 Does "Relativity" develop the pupil's concepts of "left" and "right"?
3 Does "Relativity" develop the pupil's ability to describe the position of an object?

Andersson (1976) contributed to the development for training studies within the framework of the Piagetian system. Firstly he tested, whether it is possible to teach two concepts not previously investigated, viz. coordination of perspectives and concepts of "left" and "right". Secondly, the training took place as regular classroom instruction (approximately 12 hours during a three month period).

Question 1 and 3 have been answered by means of an experiment with randomly assigned experimental and control classes. The E-group consisted of 6 classes (3 with eight-year-olds, 3 with nine-year-olds). The C-group consisted of 6 classes (3 with eight-year-olds, 3 with nine-year-olds).

As to the ability to coordinate perspectives, the experiment showed that the E-group relative to the C-group developed significantly with respect to the development from egocentricity to total decentralisation because of the instruction. A text designed by the Canadian psychologists, M. Laurendau and A. Pinard, has been made use of. When it comes to the concepts of "left" and "right", the developmental level of the pupils was diagnosed by another test designed by the above-mentioned psychologists. The E-group improved significantly with respect to the development of the concepts of "left" and "right" compared to the C-group, due to the fact that E-group pupils took part in the unit on "Relativity".

The ability to describe the position of an object was measured by means of the "describing positions in pictures" test, designed by Andersson (1976). The pupils were questioned where a certain object is situated in two large pictures hanging on a wall. A sheme of analysis for the language of the pupils was constructed, based on three types of spatial locations: topological, projective and Euclidian. The experiment shows that the E-group pupils, relative to the C-group pupils, owing to their partaking in the unit "Relativity", produce a significantly greater number of projective locations with unambiguous reference objects. Furthermore, the E-group makes significantly fewer irrelevant statements than the C-group. (See ANDERSSON, 1976, pp 15-18.)

Note 2

The LMN-project was a developmental project for improving science instruction at the junior and intermediate level of the Swedish nine year compulsory school based on the American SCIS-projet (Science Curriculum Improvement Study). The LMN-project (Låg och Mellanstadiets Naturvetenskapliga undervisning) started in 1968 and was completed in July 1976 (See NR, 1974 and Lundeberg & Norén, 1975). The project was sponsored by the National Board of Education. Teachers from the Departments of Physics, Chemistry, Biology, Educational Research, Junior Level Teaching and Intermediate Level Teaching were members of the LMN-staff. Assistant Professor Nils Svantesson, Department of Physics, was the project head. Dr. Björn Andersson served as assistant project head. (See Note 1.)

ACKNOWLEDGEMENT

I have consulted several persons in order to obtain as true a picture as possible of the present conditions and status of research in science education in Sweden. Some of them are mentioned and many others are not. I thank them all.

REFERENCES

Andersson, Bengt-Erik (1976). Barn, utveckling och samhälle. En presentation av den barnpsykologiska forskningsgruppens verksamhet och forskningsinriktning. (Children's Development and Society. A Presentation of the Activities of the Child Psychology Research Group and its Direction of Research). Report No. 3, FAKTA och DEBATT (FACTS and DEBATE), Institute of Education, Stockholm School of Education.

Andersson, Björn (1973). Some Simple Experiments Illustrating School Children's Entry into the Stage of Formal Operational Thought. Report No. 1 in COGNITIVE IMPULSE (KOGNITIV IMPULS), Department of Physics, Mölndal (Gothenburg) School of Education. (The paper has been described in Pedagogiska Meddelanden (PM), No. 8, 9 and 10, 1973, The National Swedish Board of Education).

Andersson, Björn (1976). Science Teaching and the Development of Thinking. Development of concrete operational thinking, and of language from the SCIS/LMN Spatial Concept Unit "Relativity of position and motion". Ph.D. diss. Göteborg Studies in Educational Sciences 20 (Eds.: Urban Dahllöf, Kjell Härnqvist and Karl-Gustaf Stukát), The Institute of Education, University of Gothenburg.

Arbetsplan för förskolan (1975) (Plan of Work for the Preschool).

1 Vår förskola. En introduktion till förskolans pedagogiska arbete. (Our Preschool. An Introduction to the Educational Work of the Preschool).
Authors: Karen Blomqvist, Anne-Marie Collin, Sture Henriksson, Brita Holm, Gunnel Johansson, Gunilla Johansson, Hillevi Klynne, Karin Linder, Ivonny Lindqvist, Gertrud Schyl-Bjurman, Siv Thorsell, Stig Thörn, Swen Winberg, Sigbritt Wollbrand, Inga-Britta Åstedt, Britta-Lena Öhman and other members of the Preschool Section, The National Social Welfare Board.

2 Vi lär av varandra. Om samspel och planering i förskolan. (We learn from each other. On Cooperation and Planning in the Preschool).
Authors: Karen Blomqvist. Editorial Group: Siv Thorsell, Gertrud Schyl-Bjurman, Inga-Britta Åstedt and Lena Johansson.

3 Vi upptäcker och utforskar. Att arbeta naturvetenskapligt i förskolan. (We discover and we explore. Working Scientifically in the Preschool).
Author: Olof Ernestam. A developmental psychology elaboration of the text: Gunilla Halldén and Ingrid Hellberg. Editorial group: Karen Blomqvist, Lena Johansson, Anders Åberg, Inga-Britta Åstedt. The National Social Welfare Board. (Liber Förlag, Stockholm)

Asplund, Olle; Wester-Hjelmstedt, Kristina and Åberg, Anders (1975). Projektplan för utvärdering av P 6 "Särskild information till förskolans personal m fl" och P 7 "Arbetsplan för förskolan". (Project plan for Evaluation of P 6 "Special Information to the Staffs of the Preschools and others" and P 7 "Plan of Work for the Preschool"). The National Social Welfare Board, Preschool Section, 1975-10-20.

ASÖ (1974) Mål för undervisningen i grundskolan och gymnasieskolan. Riktlinjer för målarbetet inom projektet"Målbestämning och utvärdering (MUT)". (Aims for Education in the 9-year Compulsory Comprehensive School. Guidelines for the Work within the Project "Determination of Goals of Evaluation (MUT))". Current News from the Board of Education (Aktuellt från Skolöverstyrelsen (ASÖ), specialnummer maj 1974).

ASÖ (1975/76:42) Riktlinjer för läroplansöversyn. Arbete med grundskolans fortatta utveckling. (Guidelines for Review of the Curriculum. Work with the Continous Development of the 9-year Compulsory Comprehensive School. (ASÖ: see above).

Benckert, Sylvia; Gabrielsson, Robert and Nordhage, Frank (1975). Icke-specifika mål i undervisningen och examination på C1-kursen i fysik. ('Non-specific' Goals in Education and Examination on C1-course Level Physics). Rapport över pedagogiskt utvecklingsarbete i fysik, PU-unit 74/75: 300, University of Umeå, Fack, S-901 87 Umeå. (Benckert is a lecturer in physics)

Bergling, Kurt (1974). The Development of Hypothetical-Deductive Thinking in Children. A Cross-Cultural Study of the Validity of Piaget's Model of the Development of Logical Thinking. IEA Monograph Studies No. 3, International Association for the Evaluation of Educational Achievement, University of Stockholm.

Bergling, Kurt (1976). Assessment of Logical thinking as part of the Evaluation and Evolution of an Integrated Curriculum. In B. Serge (Ed.) Physics, Biology, Mathematics: Different cognitive approaches in an integrated curriculum. Rome: Accademia Nazionale dei Lincei.

Bjerstedt, Åke (Ed.) (1975). Pedagogisk forskning i Sverige: En sexårsbiografi. Forskningsrapporter och högre examensarbeten från institutioner för pedagogik vid lärarhögskolor och universitet, 1969--1974. (Education Research in Sweden:A Six-Year Bibliography. Research Reports and Higher Examination Studies by Educational Institutes at Schools of Education and Universities 1969-1974). Department of Educational and Psychological Research, Malmö School of Education.

Bjerstedt, Åke (Ed.) (1976). Svensk pedagogik 1975: Notiser om institutionella rapportserier och högre examensarbeten vid universitetens och lärarhögskolornas institutioner för pedagogik. Nr. 39 in Pedagogisk dokumentation, Malmö School of Education.

Comber, L.C. & Keeves, John P. (1973). Science Education in Nineteen Countries. An Empirical Study. International Studies in Evaluation I. International Association for the Evaluation of Educational Achievement, University of Stockholm.

Educational Research in Sweden 1971-1972
(Under the guidance of the Council of Europe's Ad Hoc Committee for Educational Research, the Documentation Centre for Education in Europe carried out and published European Surveys on Educational Research at two-year intervals. The first two surveys were published by the Documentation Centre for Education in Europe, Strassbourg, 1969 and 1971. The present volume is the first in a series of biannual surveys. It is the result of an international project, undertaken by member governments of the Council of Europe. The basis is a questionnaire, elabora-

ted by the Ad Hoc Committee. The acquisition of data for the third survey was completed in September 1976. The volumes in the biannual survey have been prepared by the National Library for Psychology and Education in cooperation with the National Swedish Board of Education, the Office of the Chancellor of the Swedish universities and the Swedish Council for the Social Science Research. The editor is first secretary of the Board of Education, Olle Överby, Section L3:1.)

Education research in Sweden 1973-1974
(See 1971-1972)

Ernestam, Olof (1972). Naturvetenskaplig begreppsbildning. (See SOU 1972:26 pp. 284-288.)

Ernestam, Olof (1975)
(See Arbetsplan för förskolan 3.)

Ernestam, Olof & Sverud, Karl-Axel (1972). Några förslag till aktiviteter för de äldre barnen i förskolan. (Some suggestions for activities for older children in the Preschool). (See SOU 1972:26).

Erasmie, Thord & Marklund, Sixten (1974). Ämneslärarutbildning. Naturvetenskapliga ämnen. Utvärdering - Diskussion. (The Training of Secondary School Teachers in Sweden. Teachers of Mathematics, Physics, Chemistry and Biology. An Evaluation and a Discussion). Final report No. 1, 1974. Summary in English. ISBN 91-7342-001-8.

FoU-katalog (1974). Forskning och Utveckling rörande den högre undervisningen; FoU-katalog över pågående och avslutade projekt. (Research and Development regarding Higher Education; R&D-Catalogue on present and completed projects). The Office of the Chancellor of the Swedish Universities.

Gisselberg, Kjell (Ed.)(1975). Rapport från konferens om forsknings- och utvecklingsarbete rörande naturorienterande och naturvetenskaplig utbildning i ungdomsskolan. Konferens på Skolöverstyrelsen 1975-04-03--04 (Report from a Conference on Research and Development Work regarding General Natural Subjects and Natural Science Education in Youth Education, Conference held at the National Board of Education. Section L3:1.)

Gustafsson, Jan-Eric (1976). Verbal and Figural Aptitudes in Relation to Instructional Methods. Studies in Aptitude-Treatment Interactions. Ph.D. diss. Göteborg Studies in Educational Sciences 17 (Eds.: Urban Dahllöf, Kjell Härnqvist and Karl-Gustaf Stukát). The Institute of Education, University of Gothenburg.

Government Bill 1975/76:39 Regeringens proposition 1975/76:39 om skolans inre arbete m m (Government Bill on Working Conditions in Swedish Schools (SIA)).

Janson, Sven (1975). Undervisningsmål som utgångspunkt vid konstruktion av målrelaterade prov. Några teoretiska och empiriska problem. Ph.D. diss. Institute of Education, University of Umeå.

Husén, Torsten; Berglind, Kurt; Fägerlind, Ingemar; Holm, Lennart; Johansson, Per Olof; Liljefors, Robert & Mattsson, Ingrid (1973). Svensk skola i internationell belysning I. Naturorienterande ämnen. (Swedish School in International Light I. Natural Orientational Subject). Institute for the Study of International Problems in Education, University of Stockholm.

Härnqvist, Kjell (1974). Training and Career Structure of Educational Researchers. A general survey of the problem area. In: Training and Career Structure of Educational Researchers. Report of the Working Party of the Educational Research Committee. Council of Europe, Documentation Centre for Education in Europe.

Kifer, Edward W.; Mattson, Ingrid & Carlid, Mats (1975). Item Analysis using the Rasch Model. Report 12, June 1975. Institute for the Study of International Problems in Education, University of Stockholm.

Kjöllerström, Bengt (1976). Universitetsläraren i näringslivet förnyar sin syn på utbildningen. (The University Teacher in the Commercial and Industrial Life renews his View on Education) PU-unit, University of Lund 76:64.

Lindberg, Yngve (1972). Laborativ uppläggning (LABUPP) av kemiundervisningen. ('Experimental design' of Education in Chemistry). The Swedish National Board of Education 1972-08-24, Dnr 1 075/72 S. (Working Group: Upper Secondary School Inspector Yngve Lindberg, Senior Master Helen Pilström and Senior Master Åke Spetz).

Lundeberg, Christer & Norén, Ragnhild (1975). Naturvetenskaplig utbildning. Kartläggning och analys. Lägesrapport och åtgärdsprogram. Förslag utarbetat av N-gruppen, en arbetsgrupp inom SÖ, Skolöverstyrelsen (SÖ) 1975-10-30. (Natural Science Education. Survey and Analysis. Situational Report and Programme of Measures. Proposals elaborated by the N-group, a work group within the Swedish National Board of Education). (Lundeberg, Head of Division S3 and Chairman of the N-group and Norén, educational consultant at Division S3 and Secretary of the N-group).

LUT (1976) Lärarroll - lärarutbildning. 1974 års lärarutbildningsutredning (LUT 74). (Teacher Role - Teacher Training. The 1974 Teacher Training Commission. (LUT 74)). (Secretary of the Commission, Olle Österling, Rector of the Mölndal School of Education. The address: LUT:s sekretariat, Skeppareg 51, S-114 58 Stockholm).

Lybeck, Leif (1972). Integration. Del I. Vetenskapsteoretiska synpunkter på integrerad undervisning. Integrationsbegreppet en styrande idé i läroplaner särskilt i de naturorienterande ämnenas lärogångar. (Integration. Part I. Theory of Science Viewpoints on Integrated Education. Integration as a Steering Concept in Curriculum especially in the Syllabus of the Natural Sciences). Report in IMPULS, Department of Physics, Gothenburg School of Education. May 1972). (Published as Report No. 50, September 1, 1973 at the Department of Theory of Science, University of Gothenburg. See R.D.T.S. (1974).) (Translated into German: Konzepte zum fächerübergreifenden naturwissenschaftlichen Unterricht, IPN-Arbeitsberichte 3. 1973) (The project was financially supported by the National Board of Education and carried out at the Department of Physics, Gothenburg School of Education

and at the Department of Theory of Science, University of Gothenburg).

Lybeck, Leif (1973). Vetenskapsteoretisk studie och rekonstruktion av archimediska forskningsprogram. Försök till en didaktisk teori över naturvetenskapligt arbetssätt. (A Study in Theory of Science and a Reconstruction of Archimedian Rechearch Programmes. An Outline of an Educational Theory on a Natural Science Way of Work). Report No. 47, July 1, 1973, Department of Theory of Science (See R.D.T.S. (1974). (The project was financially supported by the National Board of Education and carried out at the Gothenburg School of Education and at the Department of Theory of Science, University of Gothenburg).

Lybeck, Leif (1974 a). En mätteori för naturvetenskaplig undervisning. (A Test Theory (Rasch Model) for Science Education). Report 110 in Rapporter från Pedagogiska institutionen, Januari 1974. Institute of Education, University of Gothenburg. (The Project was sponsored by the National Board of Education and carried out at the Gothenburg School of Education).

Lybeck, Leif (1974 b). Vetenskapsteori för naturvetenskaplig undervisning. En förstudie. (Theory of Science of Natural Science Education. A Preparatory Study). Report No. 60, May 20, 1974, Department of Theory of Science, University of Gothenburg. (The Project was financially supported by the National Board of Education, and carried out at the Department of Theory of Science, University of Gothenburg).

Lybeck, Leif (1975). Kartläggning av forsknings- och utvecklingsarbete inom skolans naturvetenskapliga sektor. (A Survey of R&D Work within the Sector of Natural Sciences of the School). Report Division S3 and L3, the National Board of Education. (A Project sponsored by the Board.)

Lybeck, Leif; Marton, Ference & Säljö, Roger (1976). Begreppsbildning inom matematik och naturvetenskapliga ämnen. Ett forskningsprojekt om gymnasieelevers förståelse av vissa fysikaliska aspekter av omvärlden. (Concept formation in Mathematics and the Natural Sciences. A research project on secondary school student's conception of certain physical aspects of the world around). Reports from the Institute of Education, University of Gothenburg, No 146, 1976.

Marton, Ference (1975). What does it take to learn? Some Implications of an alternative view of learning. Educational Research Symposium on Strategies for Research and Development in Higher Education, Gothenburg, Sweden, September 7—12, 1975, Committee for Education Research, Council for Cultural Cooperation, Council of Europe, Strasbourg, May 16, 1975.

Marton, Ference (1976). Skills and an Aspects of Knowledge. Some Implications from Research on Student's Conceptions of Central Phenomena in their Subjects. Paper presented on the Second International Conference on Improving University Teaching, July 13—16, 1976, Heidelberg, F.R. Germany.

MUT (1973) Underlag för debatt om utvecklingsprogram för skolan. Projektet "Målbestämning och utvärdering (MUT)". (Basic Documents for Discussions on Programme of Development for the School. The project "Determination on Goals and Evaluation (MUT)".) The National Board of Education.

Naturvetargruppen (1976) (The Group of Natural Science Men). Universitetsutbildning för naturvetare. Rapport från UKÄ:s arbetsgrupp för organisation av utbildningen vid matematisk-naturvetenskaplig fakultet. (Training of Science Students at University Level. Report from a Work Group appointed by the Office of the Chancellor of the Swedish Universities on the Organization of Training at Faculty of Science). Report 1976:3. (Members: Professor Kerstin Lindahl-Kiessling, Chairman, Professor Bert Bolin (meteorology), Assistant Head of Division Karl-Axel Edin, Professor Tord Ganelius (mathematics), B.Sc. Ulf Hanning, Research Director, Dick Lundqvist, Assistant Professor Bengterik Ronne (physics) and Director of Studies Leif Sanner).

Nordberg-Dahlgren, Gertrud & Karlsson, Börje (1976). Delredovisning av pågående PU-projekt i Biologi för budgetåret 1975/76. (Partial report of present PU-projects in Biology for the fiscal year 1975/76). University of Lund, Biologiska övningslaboratoriet Ekologihuset, Helgonavägen 5, S-223 62 Lund.
(G. N.-D. & B.K. are lecturers in biology).

NR (1974) Naturorienterande ämnen i grundskolan i Norden årskurserna 1-6. Nordiskt samarbete inom undervisningsområdet. Nordiska rådet, Nordisk utredningsserie 2/74. (Sekretariatet för nordiskt kulturellt samarbete, Snaregade 10, Dk-1205 Copenhagen, Denmark). (Natural Orientation Subjects in the 9-year Compulsory Comprehensive School of the Finno-Scandinavian Countries Grades 1-6.)

PM (1976) Temanummer om naturvetenskaplig undervisning (Theme Number on Natural Science Education). Pedagogiska Meddelanden, Nr 9, 1975. (Educational Information from the National Swedish Board of Education.)

R.D.T.S. (1974) Research Activities in the Department of Theory of Science. Department of Theory of Science, University of Gothenburg, Report No. 68, September 5, 1974. (Södra Vägen 61, S-412 54 Gothenburg, Sweden.)

Sandgren, Björn (1974). Kreativ utveckling. En empirisk studie av kognitiv utveckling samt en kritisk analys av intelligensbegreppet. (Creative Development. An Empirical Study of Cognitive Development and a Critical Analysis of the Concept of Intelligence.) Ph.D. diss., Göteborg Studies in Educational Sciences 11 (Eds.; Urban Dahllöf, Kjell Härnqvist and Karl-Gustaf Stukát). (The research was financially supported by the Swedish Council for Social Science Research and was carried out at the Institute of Education, University of Gothenburg).

SCB (1974 a) Utbildningsstatistik, 1960—1973. (Swedish Educational Statistics 1960—1973) The National Central Bureau of Statistics (SCB), Report No. 1974:3, Promemorior från SCB, February 1974.

SCB (1974 b) De senaste årens utveckling på utbildningsområdet. Analys av utbildningsstatistik. (Tendencies in Education During Recent Years. An Analysis of Educational Statistics). The National Central Bureau of Statistics (SCB), Report No.1974:6, Information i prognosfrågor (Forecasting Information), May 10, 1974.

SCB (1975 a) Befolkningens utbildning 1970—2000. (The Swedish Population by Level of Education 1970—2000). The National Central Bureau of Statistics (SCB), Report No. 1975:3,Information i prognosfrågor (Forecasting Information), July 7, 1975.

SCB (1975 b) Högskolestatistik I. Nyinskrivna, närvarande och examinerade vid universitet och högskolor 1962/63—1971/72. (Swedish University Education I. Statistics on Entrants, Registred and Graduated Students 1962/63—1971/72.) Promemorior från SCB 1975:2. The National Central Bureau of Statistics.

SOU (1970:22)Pedagogisk utbildning och forskning. Betänkande avgivet av Pedagogutredningen. (Educational Training and Research. Report submitted by the Pedagogic Commission.) State Official Reports (SOU 1970:22), The Ministry of Education and Cultural Affairs.

SOU (1972:26 & 27) Förskolan. Part 1 (26) & Part 2 (27). Betänkande avgivet av 1968 års barnstugeutredning. (Preschool. Part 1 (26) & Part 2 (27). Report submitted by the 1968 Child Centre Commission.) State Official Reports (SOU 1972:26 & 27), The Ministry of Health and Social Affairs.

SOU (1973:2) Högskolan. Förslag av 1968 års utbildningsutredning, U 68. (The University. Proposal of the 1968 Educational Commission U 68). State Official Reports SOU 1973:2, The Ministry of Education and Cultural Affairs.

SOU (1973:3) Högskolan. Sammanfattning av förslag av 1968 års utbildningsutredning. U 68. (Summary of SOU 1973:2)

SOU (1974:36) Skolan, staten och kommunerna (SSK). En redovisning av nuvarande ansvarsfördelning mellan stat och kommun i fråga om grundskolan och gymnasieskolan m m. (Schools, the State and Local Authorities. An account of the Present Allocation of Responsibilities between the State and Local Authorities in Regard to the 9-year Compulsory Comprehensive School and the Integrated Upper Secondary School etc.) The Royal Commission on the Schools, the State and the Municipalities, State Official Reports SOU 1974:36, The Ministry of Education and Cultural Affairs. (In English a stenciled paper by Lennart Teveborg: School, the State and Local Authorities in Sweden, 1974-09-05, Secretary of the Commission. Teveborg is Head of the Department of the School (S) at the National Swedish Board of Education.)
(Chairman of the Commission was the Director-General of the National Swedish Board of Education, Jonas Orring).

SOU (1974:53) Skolans inre arbetsmiljö - Betänkande avgivet av utredningen om skolans inre arbete - SIA. (The Working Mileu in the School. Report submitted by the Royal Commission on Working Conditions in Swedish Schools - SIA.), State Official Reports SOU 1974:53, The Ministry of Education and Cultural Affairs. (Stenciled paper: Royal Commission on Working Conditions in Swedish Schools (SIA). Summary of the Final Report, Ministry of Education 1974-09-02.)
(Chairman of the Commission was the Director-General of the National Board of Education, Jonas Orring.)

SOU (1975:58) Appendix to SOU 1974:53.

Stukát, Karl-Gustaf (1974) Research on Preschool Programmes in Sweden. Paedagogica European IX/1974/1. L.C.G. Malmberg/Westermann

Stukát, Karl-Gustaf & Sverud, Karl-Axel (1974). (The Gothenburg Preschool Project.) Utbildningsforskning rapport 11 (Educational Research Reports presenting projects supported by the National Board of Education), The National Board of Education 1974. (A Summary in English.)

Svensk utbildningsforskning (1974) (Swedish Educational Research) Skolöverstyrelsen, Byrån för pedagogiskt forsknings- och utvecklingsarbete (L3), elfte utgåvan, 1974-10-10, (The National Swedish Board of Education, The Division for Educational R&D Work (L3), 11th publication, October 10, 1974. The publication contains short descriptions of research projects and investigations concerning education at preschool, school and university levels during the fiscal year 1973/74. A selection was made. Developmental work experimental activities and reform work were left out.)

Svensk utbildningsforskning (1975) (Swedish Educational Research) The National Swedish Board of Education, 12th publication, 1975-10-10. (Fiscal year 1974/75. See above. Certain projects started during the fiscal year 1975/76 are included.)

Swedish Behavioural Science Research Reports (1973/74)
(The Report contains abstracts of current research and has been prepared by the National Library for Psychology and Education. Financial support has been added by the Swedish Council for Social Science Research. The acquisition of data was completed in October 1974. The contributing institutions are responsible for the selection of the reports submitted for the survey.)

Swedish Behavioural Science Research Reports (1974/75)
See 1973/74. Additional copies of this survey can be obtained from The National Library for Psychology and Education, P.O. Box 23099, S-104 35 Stockholm.

SÖ-grupp i Biologi (1976). Biologi på 3-årig naturvetenskaplig linje i gymnasieskolan. Strukturering av stoff - Arbetsformer. (Biology in the 3-year Natural Science Line of the Integrated Upper Secondary School. Structure of Content - Forms for Work.) The National Board of Education, Division S3, February 2, 1976. (Group: Upper Secondary School Inspector Sten Forselius, director of the project, Senior Master Sven-Anders Björse, Senior Master Anders Ehn, Assistant Master Harry Esbjörnsson, Associate Chief Education Director Reinhold Ivarsson and Assistant Master Allan Vilemark.)

Vestin, Margareta (1975 a) Ett friare val. Del 1 Könsrollskunskap. (1975 b) Ett friare val. Del 2 Jämnställdhetsprogram för skolan. Rapporter från Skolöverstyrelsens projekt "Könsrollerna i skolan", 1974-04-08. Referensupplaga. (The Sex Role Project of the National Board of Education. Project leader Margareta Vestin, Head of Division S6.)

Vestin, Margareta (1975 c). Ett friare val. Jämställdhetsprogram för skolan. Rapport från Skolöverstyrelsens projekt "Könsroller i skolan". Pocketupplaga av referensupplagan (1975 a & b). Utbildningsförlaget Liber Läromedel, S-162 89 Vällingby.

Vestin, Margareta (1975 d). Så gjorde vi... Rapport från könsrollsprojektets modellskolor. Vallaskolan, Sala. Kungshögaskolan, Mjölby. Bilaga nr 1 till huvudrapporten (1975 a & b).

Åkerblom, Dick (1972). Naturvetenskaplig begreppsbildning - biologi. (See SOU 1972:26.)

ADDRESSES

Ministries

The Ministry of Education and Cultural Affairs
Fack, S-103 10 STOCKHOLM

The Ministry of Finance
Fack, S-103 10 STOCKHOLM

The Ministry of Health and Social Affairs
Fack, S-103 20 STOCKHOLM

National Boards

The Central Bureau of Statistics
Fack, S-102 50 STOCKHOLM

The Office of the Chancellor of the Swedish Universities
Box 16 334, S-103 26 STOCKHOLM

The National Board of Education
Fack, S-106 42 STOCKHOLM

The National Social Welfare Board
Fack, S-106 30 STOCKHOLM

Research Councils

The Swedish Council for Social Science
Sveavägen 166, S-113 46 STOCKHOLM

University Departments of Education

Institute of Education, University of Gothenburg
Fack, S-431 20 MÖLNDAL

Department of Education, University of Linköping
S-581 83 LINKÖPING

Institute of Education, University of Lund
Fack, S-220 07 LUND

Institute for the Study of International Problems
in Education, University of Stockholm
Fack, S-104 05 STOCKHOLM

Institute of Education, University of Stockholm
Fack, S-104 05 STOCKHOLM

Department of Education, University of Umeå and Umeå
School of Education
S-901 87 UMEÅ

Institute of Education, University of Uppsala
S-752 21 UPPSALA

Teacher Training Colleges

Department of Education and Educational Research
Linköping School of Education
S-582 23 LINKÖPING

Department of Educational Research,
Linköping School of Education
P.O. Box 3129, S-580 03 LINKÖPING

Department of Educational and Psychological Research
Malmö School of Education
Fack, S-200 45 MALMÖ 23

Department of Education, Stockholm School of Education
Fack, S-100 26 STOCKHOLM 34

Department of Education, Uppsala School of Education
S-753 22 UPPSALA

Department of Education, Mölndal School of Education
Fack, S-431 20 MÖLNDAL

58 Sandgren, Björn: Relation between cognition and social development. January 1977.

59 Entwistle, Noel: Changing approaches to research into personality and learning. February 1977.

60 Härnqvist, Kjell: Primary Mental Abilities at collective and individual level. October 1977,

61 Härnqvist, Kjell: Enduring effects of schooling. - A neglected area in educational research. October 1977.

62 Härnqvist, Kjell: A note on the correlations between increments, cumulated attainment and a predictor. October 1977.

63 Gustafsson, Jan-Eric: The Rasch model for dichotomous items: Theory, applications and a computer program. December 1977.

64 Härnqvist, Kjell and Stahle, Gun: An ecological analysis of test score changes over time. December 1977.

65 Dahlgren, Lars Owe: Effects of university education on the conception of reality. May 1978.

66 Marton, Ference: Describing conceptions of the world around us. August 1978.

67 Gustafsson, Jan-Eric and Lindblad, Torsten: The Rasch model for dichotomous items: A solution of the conditional estimation problem for long tests and some thoughts about item screening procedures. June 1978.

68 Marklund, Ulla: Smoking in compulsory schools. Interviews and improvisations. September 1978.

69 Svensson, Lennart: Some notes on a methodological problem in the study of the relationship between thought and language. - Describing the thought content in terms of different conceptions of the same phenomenon. September 1978.

70 Härnqvist, Kjell and Gustafsson, Jan-Eric: International references to Swedish educational research: A citation study. October 1978.

71 Lybeck, Leif: A research approach into science education at Göteborg. October 1978.

72 Lybeck, Leif: Studies of mathematics in teaching of science in Göteborg. October 1978.

73 Gustafsson, Jan-Eric and Lindström, Berner: Describing and testing aptitude-treatment interaction effects with structural equation models: Reanalysis of a study by M J Behr. December 1978.

74 Lybeck, Leif: Research in Science Education: Sweden 1976. Paper presented at the Council of Europe Contact Workshop 'Research in Science Education in Europe. Improvement of research activities and results.' October 27--29, 1976, Malente-Gremsmühlen (Kiel), Federal Republic of Germany. December 1978.